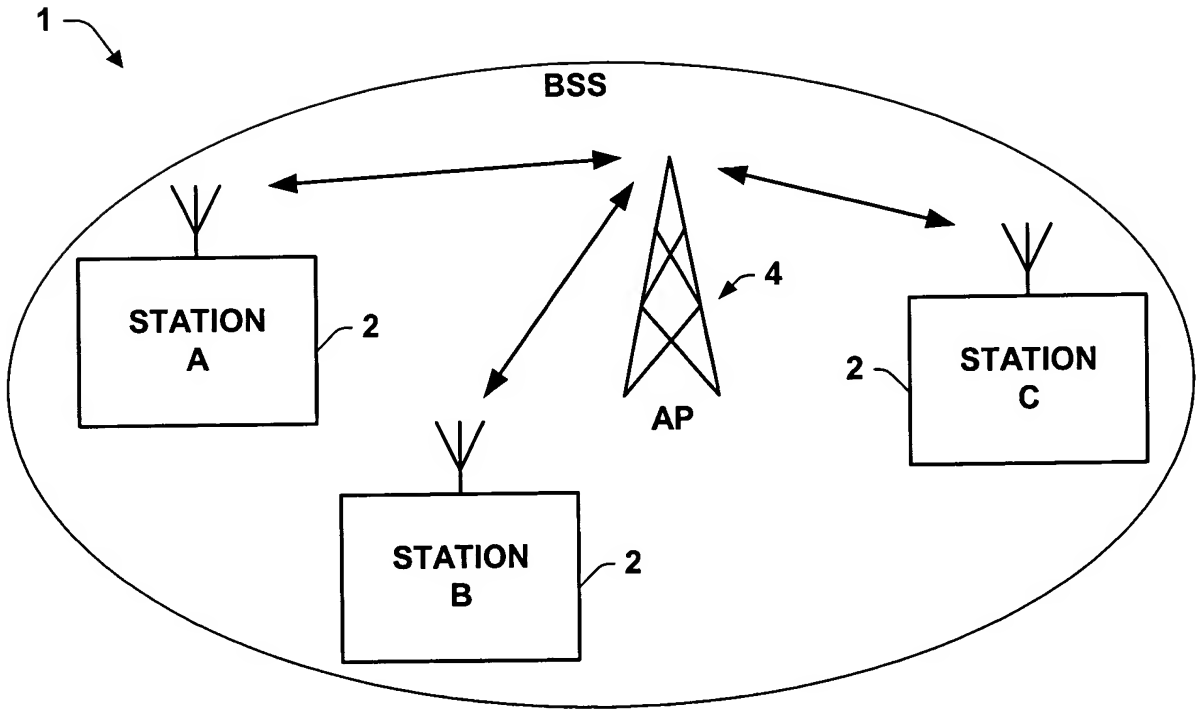

FIG. 1
PRIOR ART

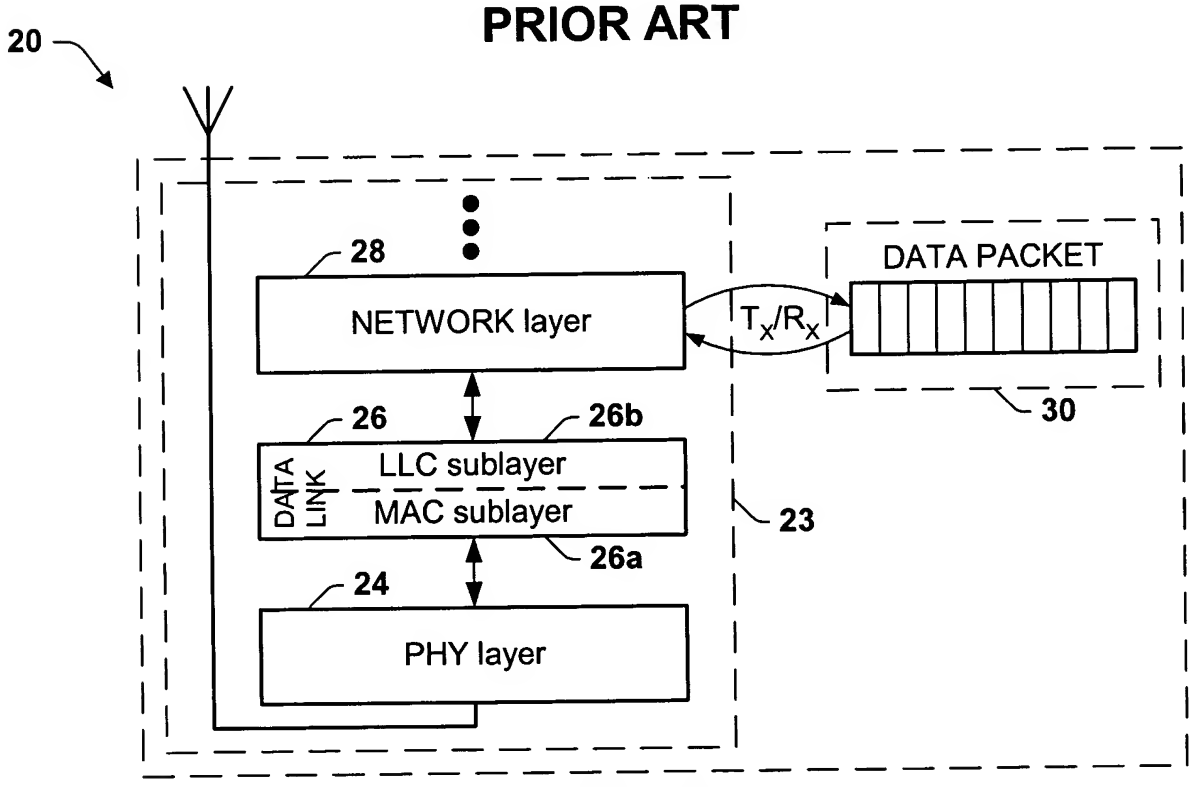

FIG. 2
PRIOR ART

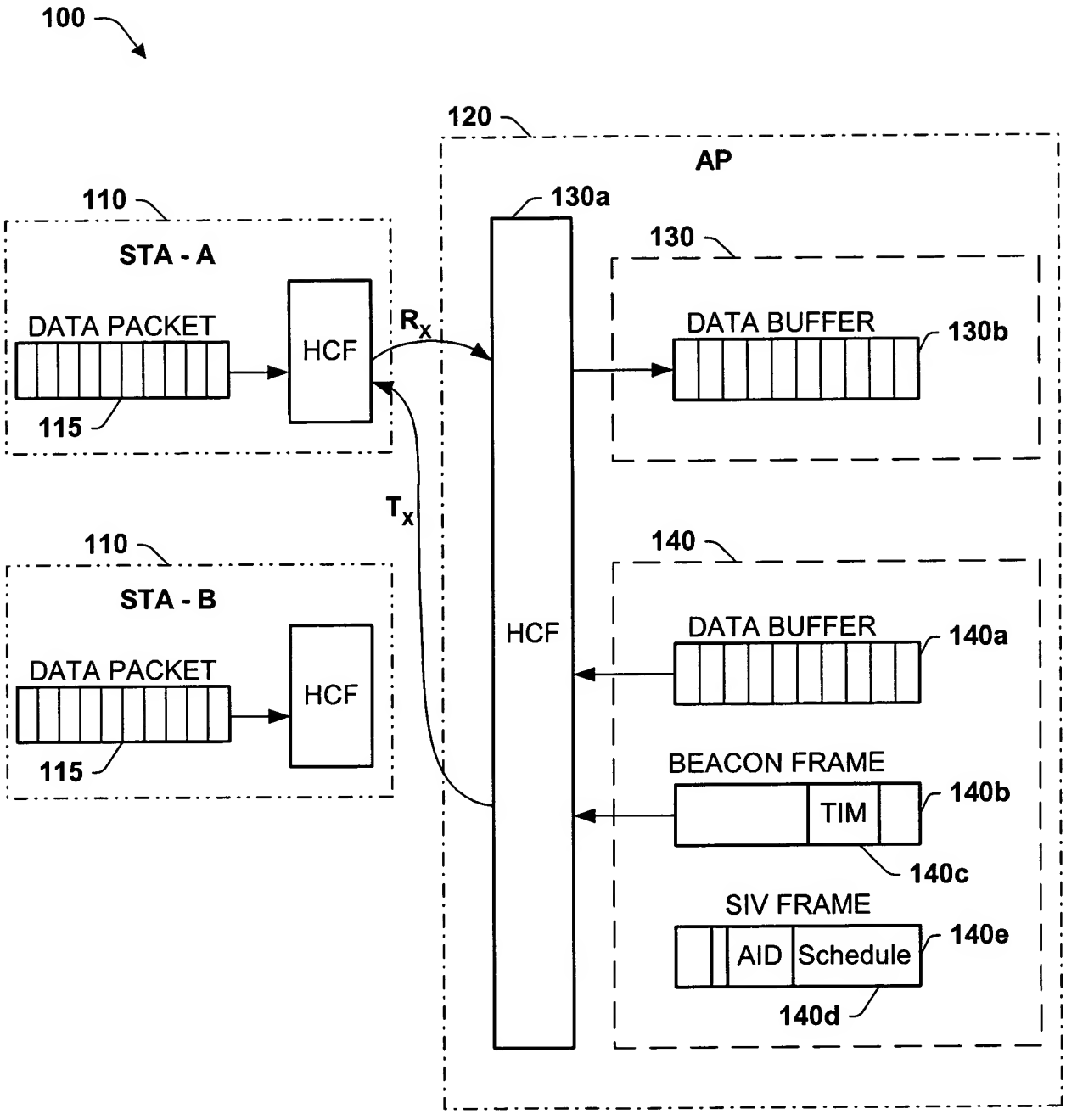
100
120
AP
110
STA - A
DATA PACKET
115
HCF
R_X
130a
130
DATA BUFFER
130b
T_X
110
STA - B
DATA PACKET
115
HCF
HCF
140
DATA BUFFER
140a
BEACON FRAME
TIM
140b
140c
SIV FRAME
AID
Schedule
140e
140d

FIG. 3

200

Inter-Frame Spaces for 802.11B DSSS (μs.)

SLOT TIME	SIFS TIME	PIFS TIME	DIFS TIME
20	10	30	50

FIG. 4

230

Frame Body of Action Frame

235	240	245	250	255	260
FIELD NAME	CATEGORY CODE	ACTION CODE	ACTIVATION DELAY	DIALOG TOKEN	ACTION BODY
BYTES	1	1	1	1	0-2300

FIG. 5A

232

Action Body of SIV Frame

235	280	285	290	295
FIELD NAME	N_{SIV}	AID	SCHEDULE	LISTENING WINDOW
BYTES	2	$2N_{SIV}$	$2N_{SIV}$	2

FIG. 5B

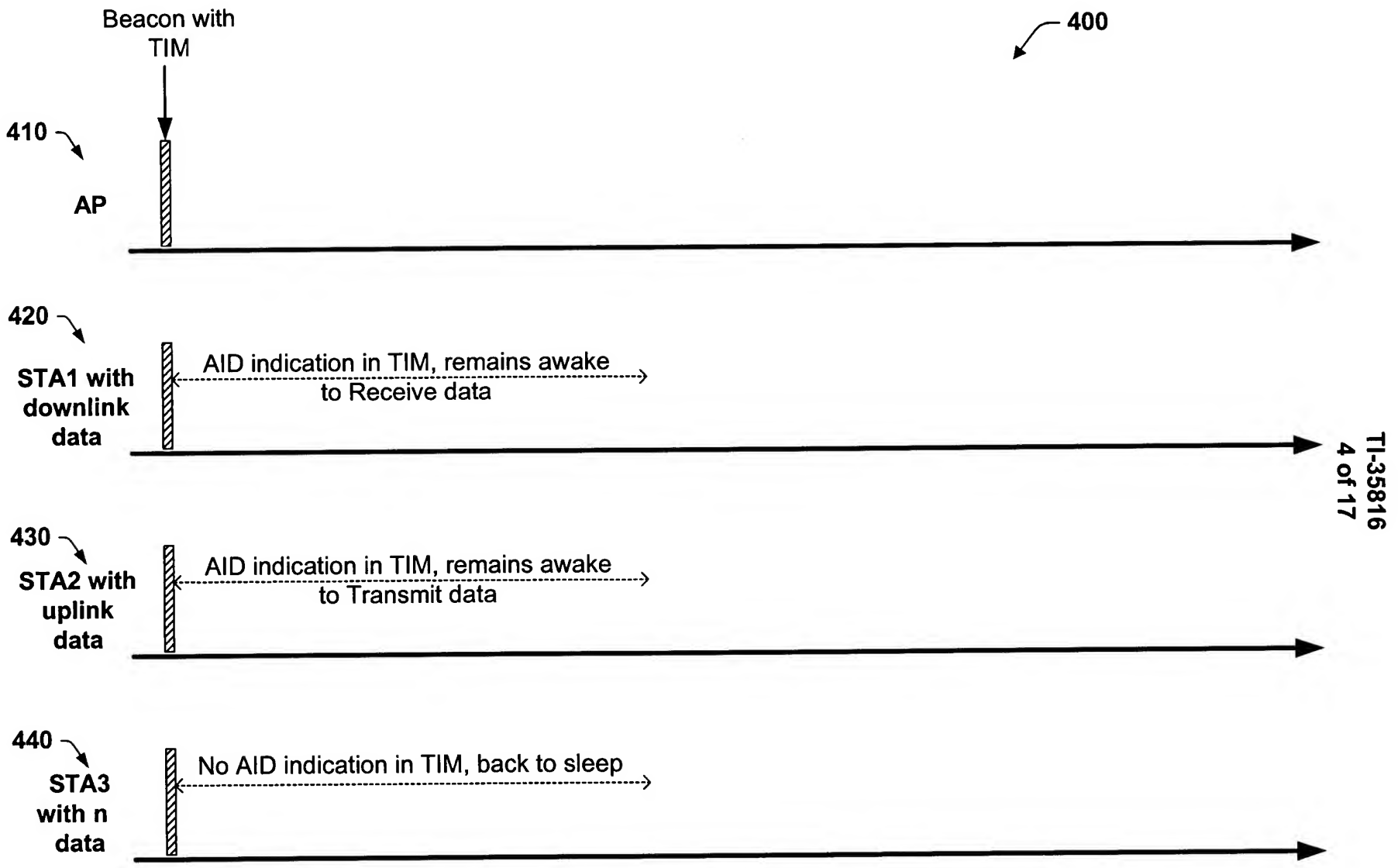
Beacon with TIM
400
410
AP
420
STA1 with downlink data
AID indication in TIM, remains awake to Receive data
430
STA2 with uplink data
AID indication in TIM, remains awake to Transmit data
440
STA3 with n data
No AID indication in TIM, back to sleep

FIG. 6A

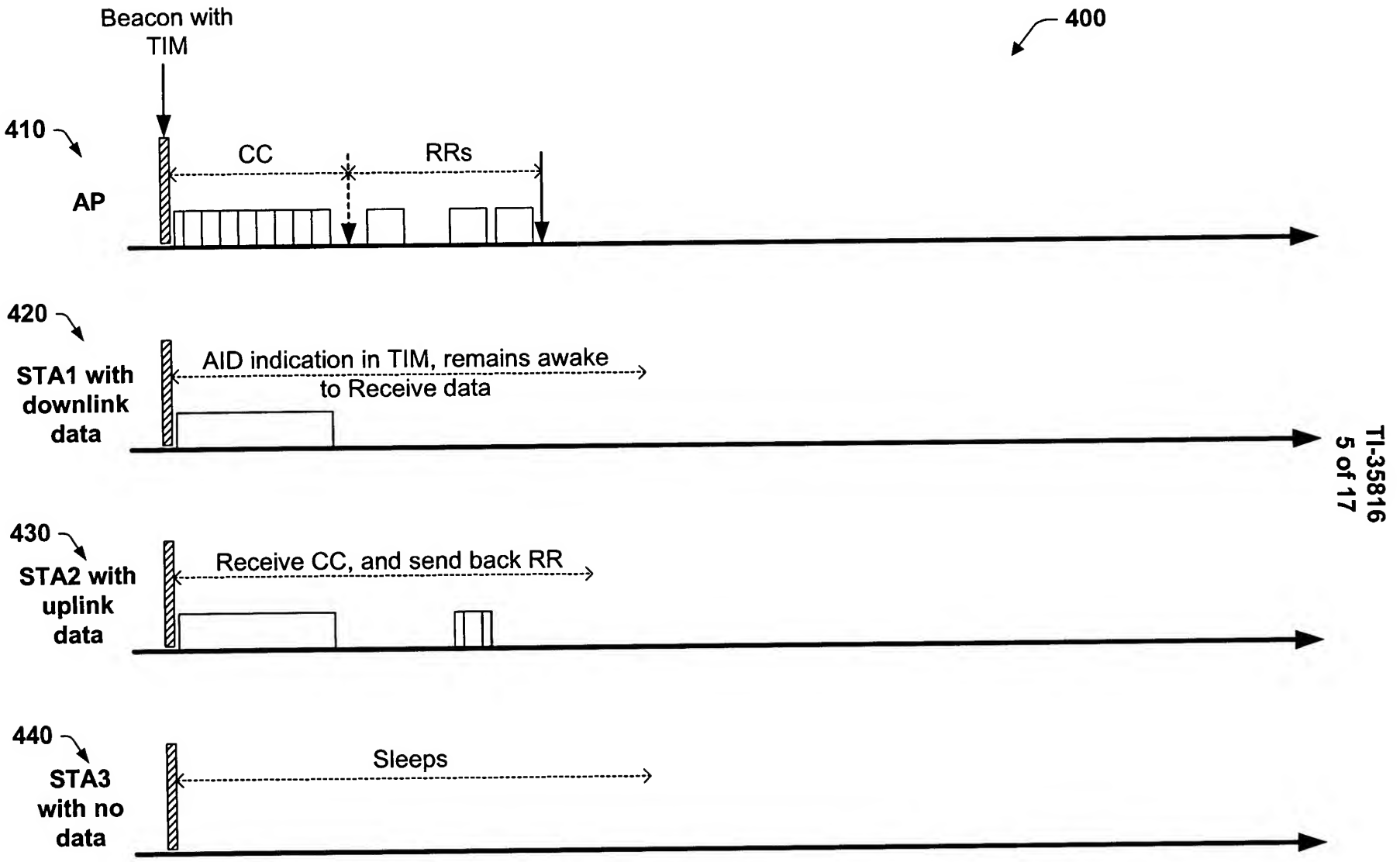
Beacon with TIM
400
410
AP
CC
RRs
420
STA1 with downlink data
AID indication in TIM, remains awake to Receive data
430
STA2 with uplink data
Receive CC, and send back RR
440
STA3 with no data
Sleeps

FIG. 6B

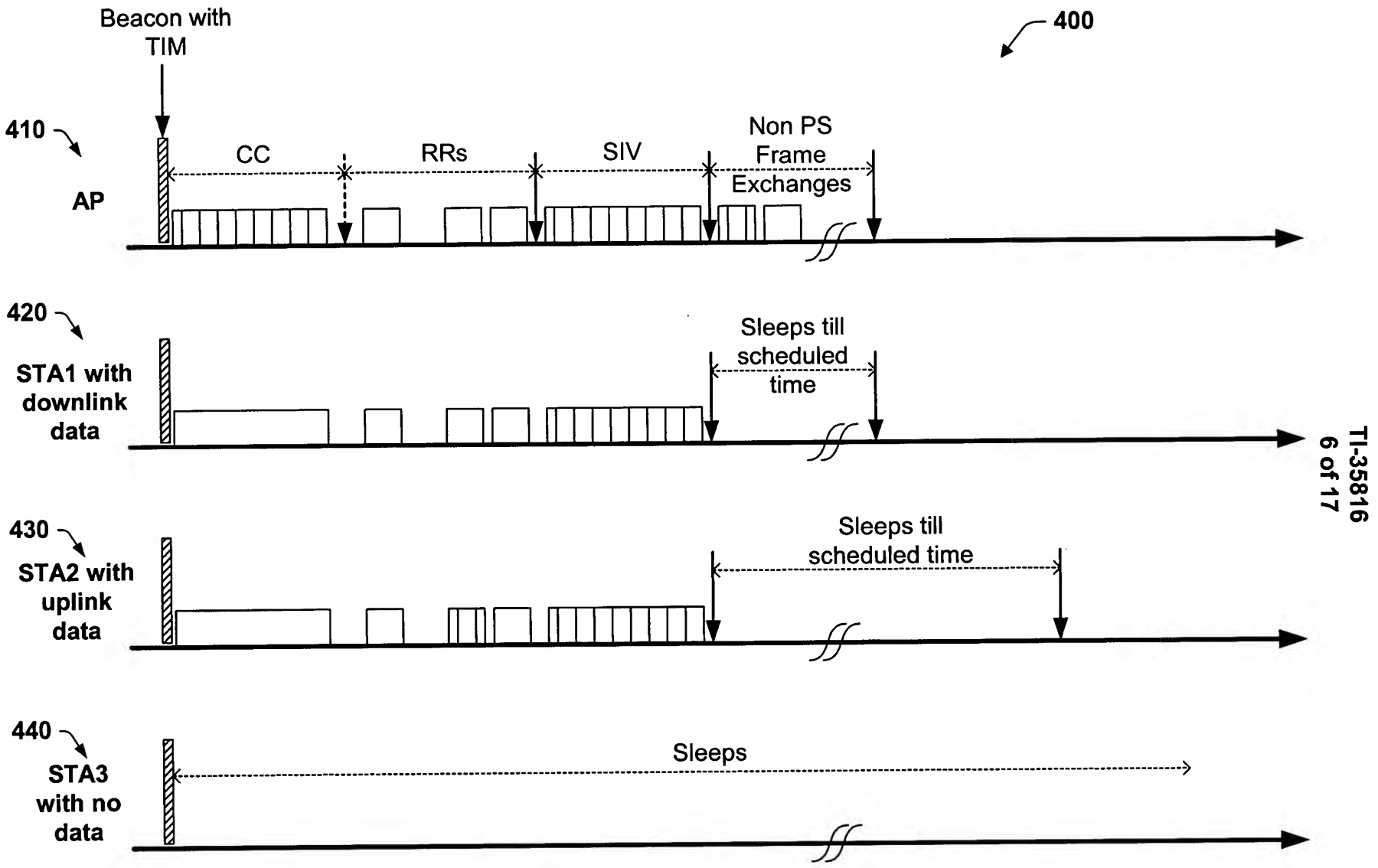
Beacon with TIM
400
410
AP
CC
RRs
SIV
Non PS Frame Exchanges
420
STA1 with downlink data
Sleeps till scheduled time
430
STA2 with uplink data
Sleeps till scheduled time
440
STA3 with no data
Sleeps

FIG. 6C

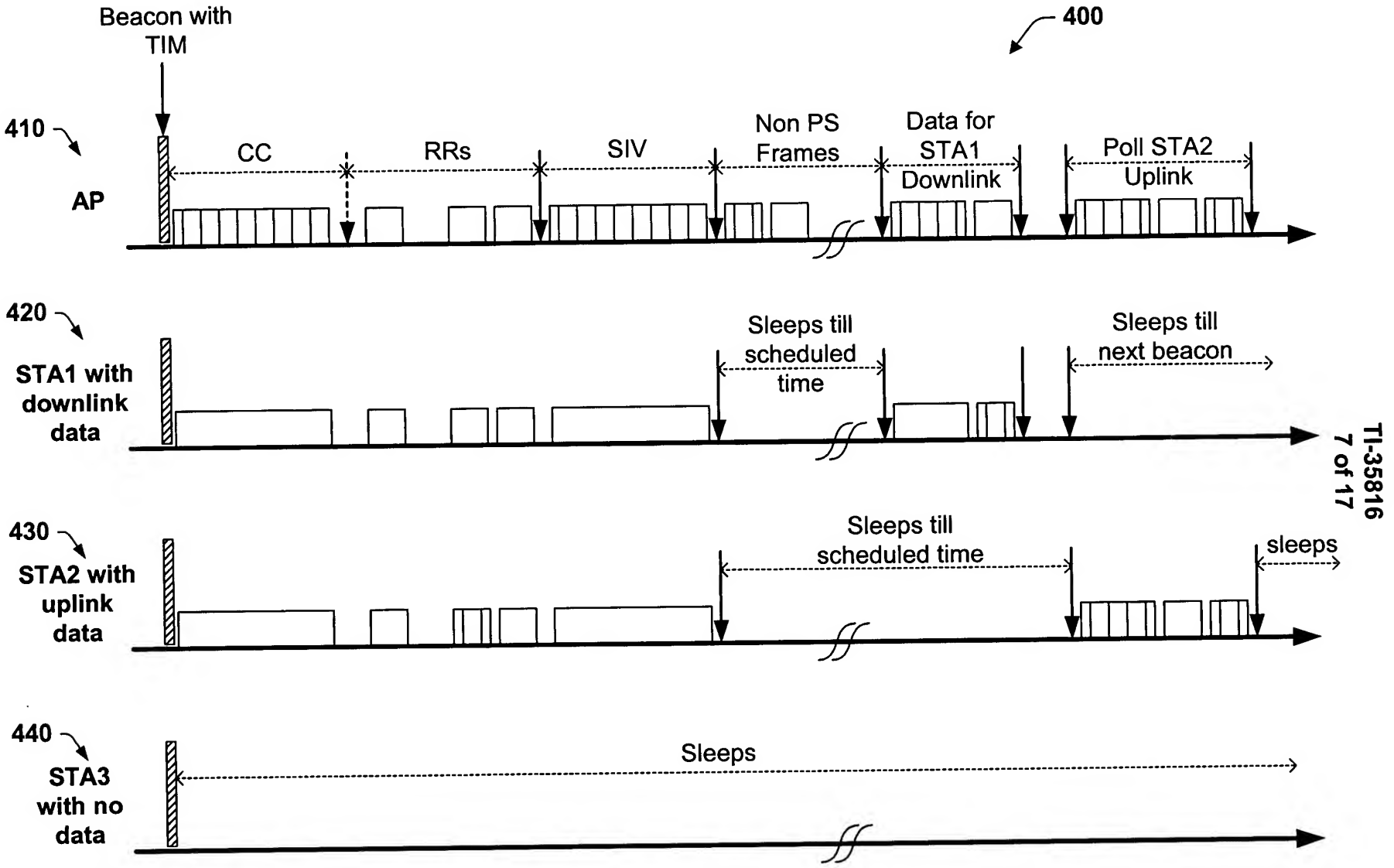
Beacon with TIM
400
410
AP
CC
RRs
SIV
Non PS Frames
Data for STA1 Downlink
Poll STA2 Uplink
420
STA1 with downlink data
Sleeps till scheduled time
Sleeps till next beacon
430
STA2 with uplink data
Sleeps till scheduled time
sleeps
440
STA3 with no data
Sleeps

FIG. 6D

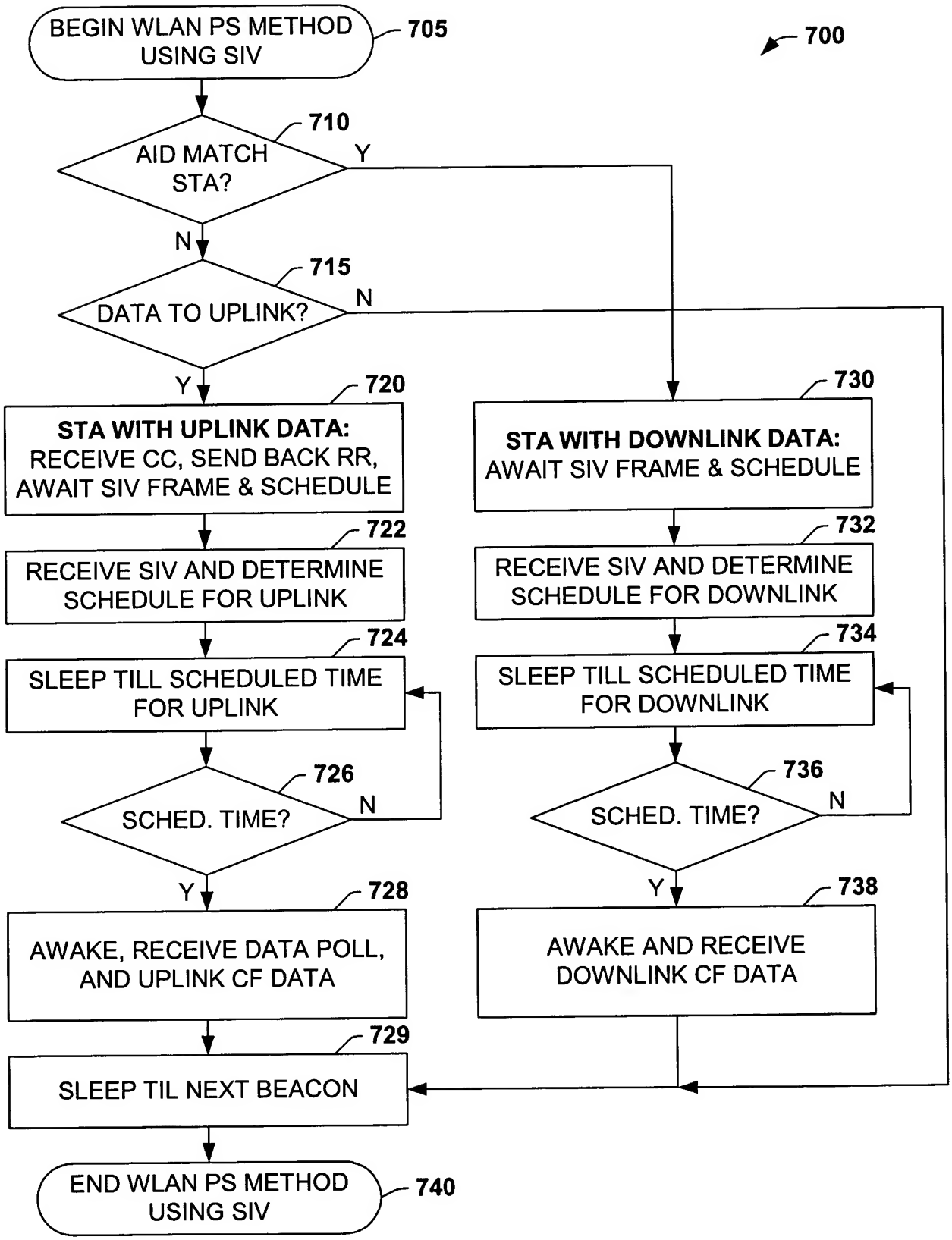
BEGIN WLAN PS METHOD USING SIV
705
700
AID MATCH STA?
710
Y
N
DATA TO UPLINK?
715
N
Y
STA WITH UPLINK DATA: RECEIVE CC, SEND BACK RR, AWAIT SIV FRAME & SCHEDULE
720
RECEIVE SIV AND DETERMINE SCHEDULE FOR UPLINK
722
SLEEP TILL SCHEDULED TIME FOR UPLINK
724
SCHED. TIME?
726
N
Y
AWAKE, RECEIVE DATA POLL, AND UPLINK CF DATA
728
STA WITH DOWNLINK DATA: AWAIT SIV FRAME & SCHEDULE
730
RECEIVE SIV AND DETERMINE SCHEDULE FOR DOWNLINK
732
SLEEP TILL SCHEDULED TIME FOR DOWNLINK
734
SCHED. TIME?
736
N
Y
AWAKE AND RECEIVE DOWNLINK CF DATA
738
SLEEP TIL NEXT BEACON
729
END WLAN PS METHOD USING SIV
740

FIG. 7

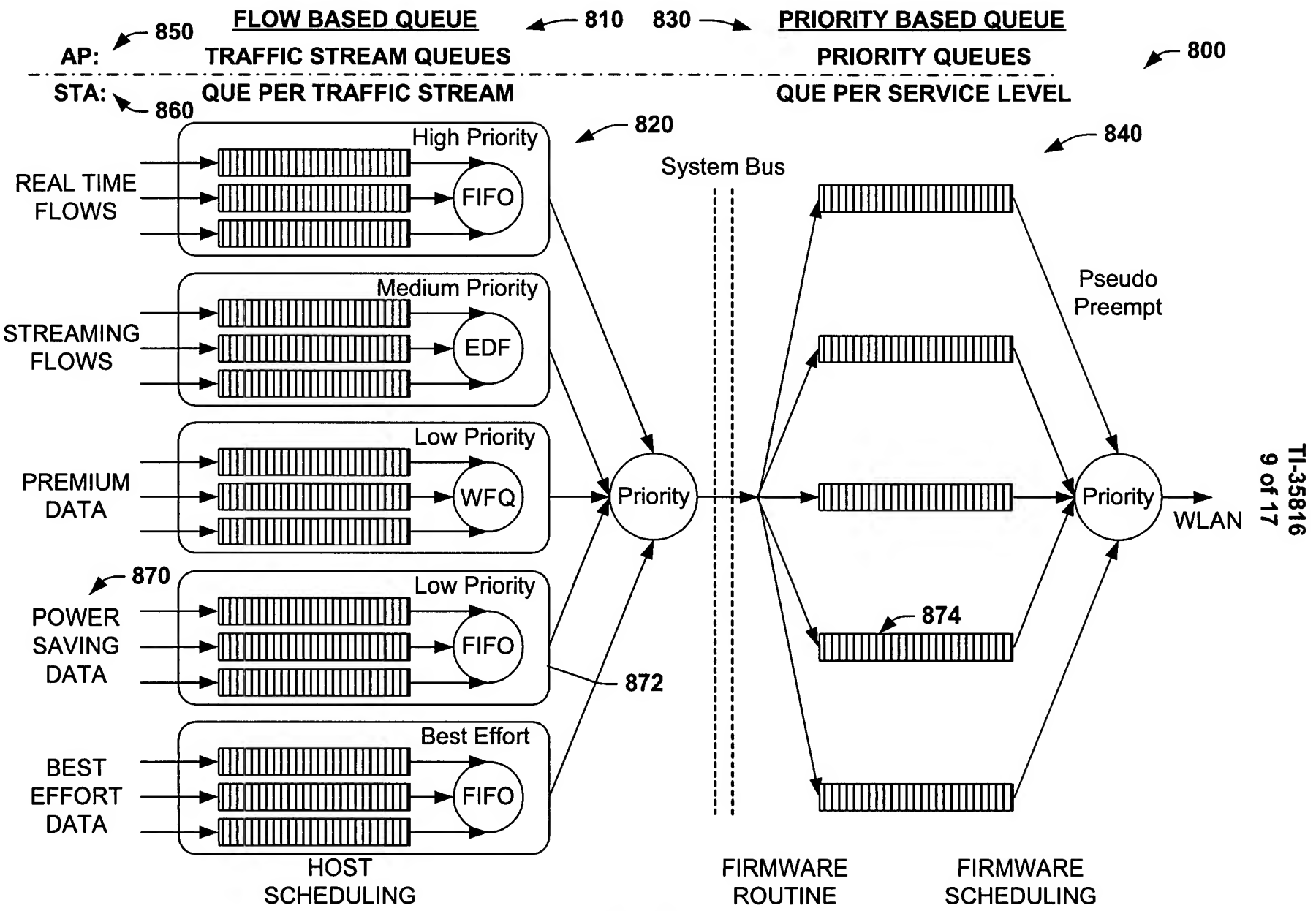
FLOW BASED QUEUE
810
830
PRIORITY BASED QUEUE
850
AP:
TRAFFIC STREAM QUEUES
PRIORITY QUEUES
800
STA:
QUE PER TRAFFIC STREAM
QUE PER SERVICE LEVEL
860
820
840
High Priority
REAL TIME FLOWS
FIFO
System Bus
Medium Priority
STREAMING FLOWS
EDF
Pseudo Preempt
Low Priority
PREMIUM DATA
WFQ
Priority
Priority
WLAN
870
Low Priority
POWER SAVING DATA
FIFO
874
872
Best Effort
BEST EFFORT DATA
FIFO
HOST SCHEDULING
FIRMWARE ROUTINE
FIRMWARE SCHEDULING

FIG. 8

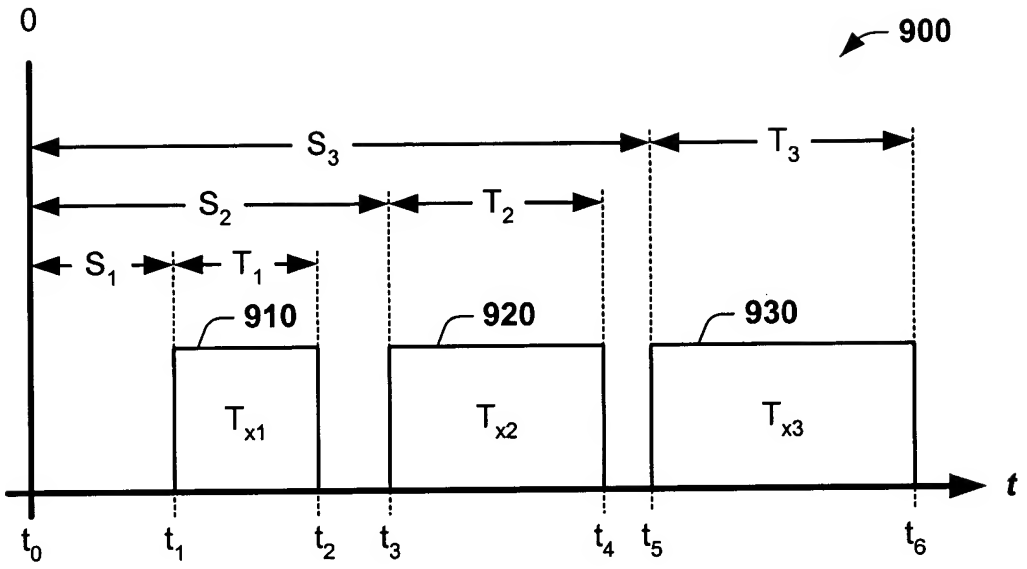
0
900
S_3
T_3
S_2
T_2
S_1
T_1
910
920
930
T_{x1}
T_{x2}
T_{x3}
t
t_0
t_1
t_2
t_3
t_4
t_5
t_6

FIG. 9

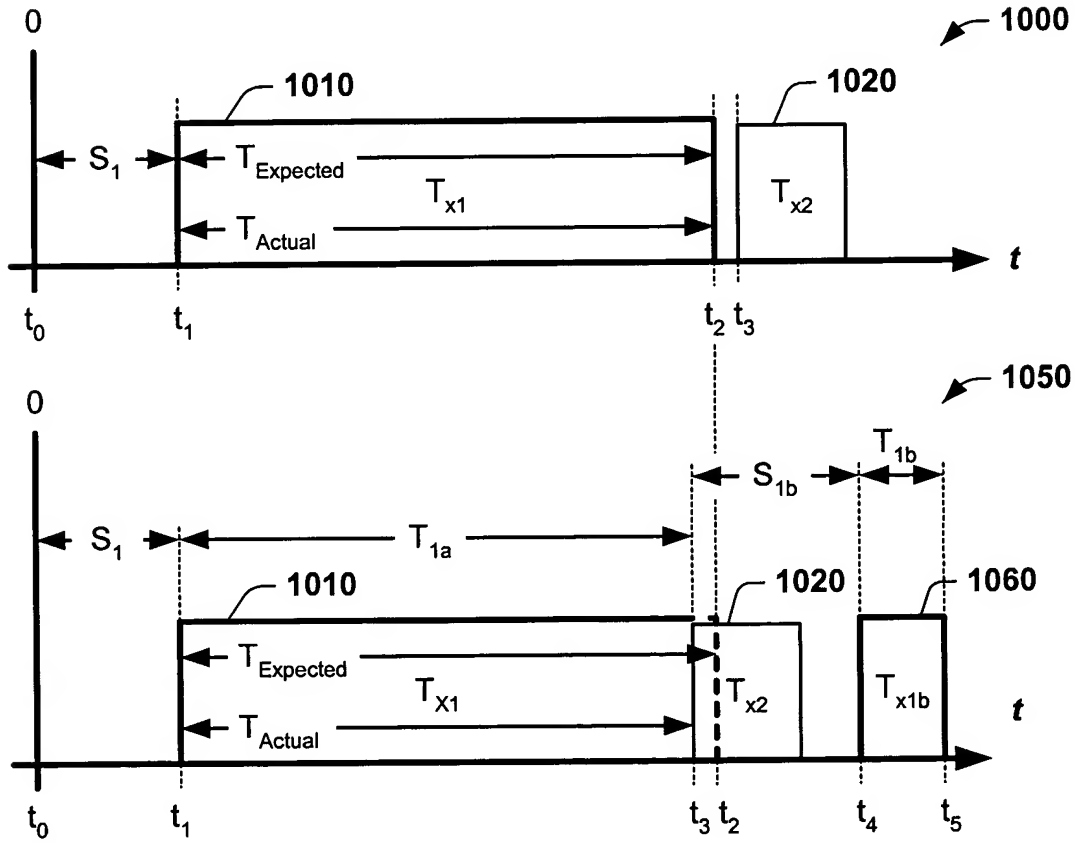
0
1000
1010
1020
S_1
$T_{Expected}$
T_{x1}
T_{Actual}
T_{x2}
t
t_0
t_1
t_2 t_3
1050
T_{1b}
S_{1b}
T_{1a}
1060
T_{x1b}
t_3 t_2
t_4
t_5

FIG. 10

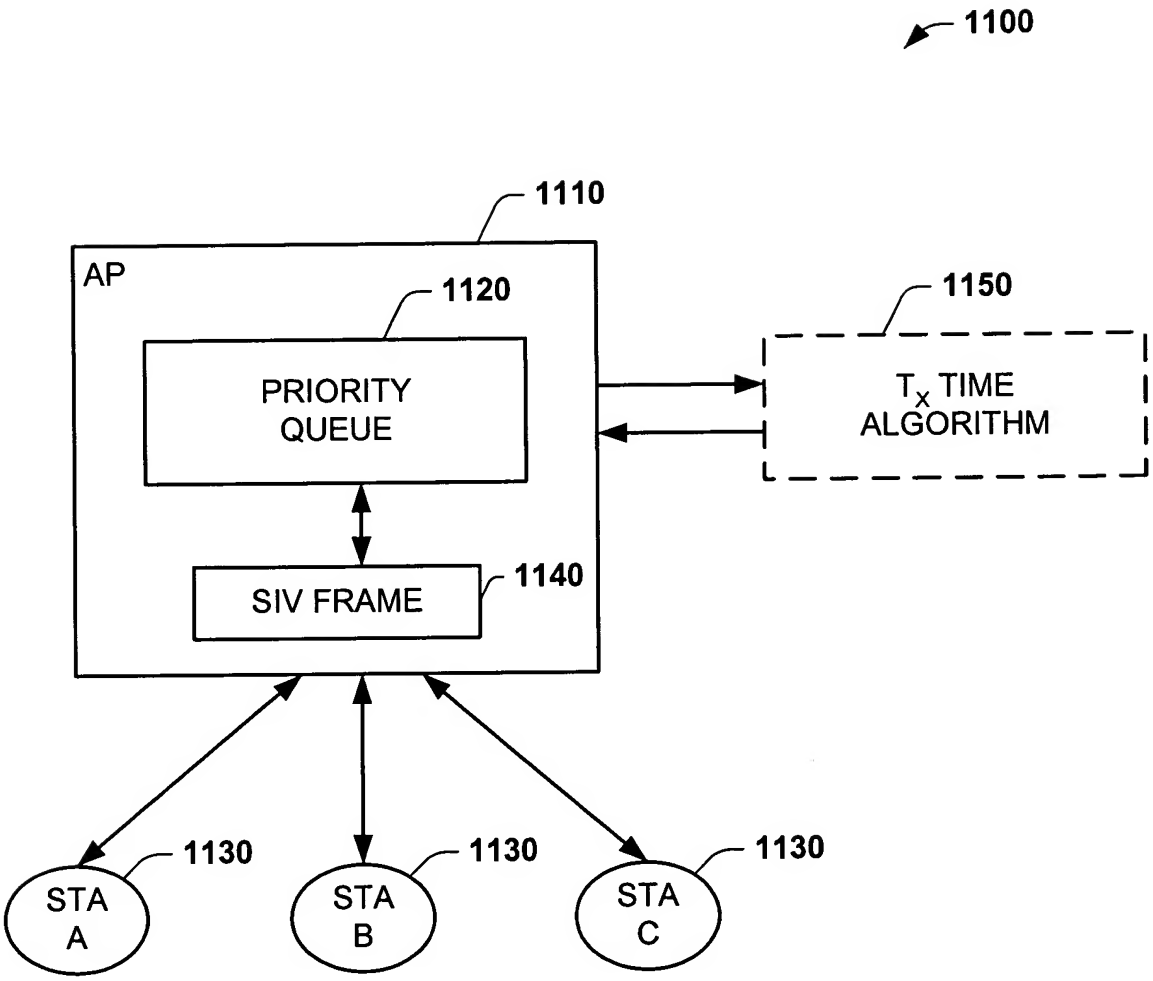
1100
1110
AP
1120
PRIORITY QUEUE
1150
T_X TIME ALGORITHM
SIV FRAME
1140
1130
STA A
1130
STA B
1130
STA C

FIG. 11

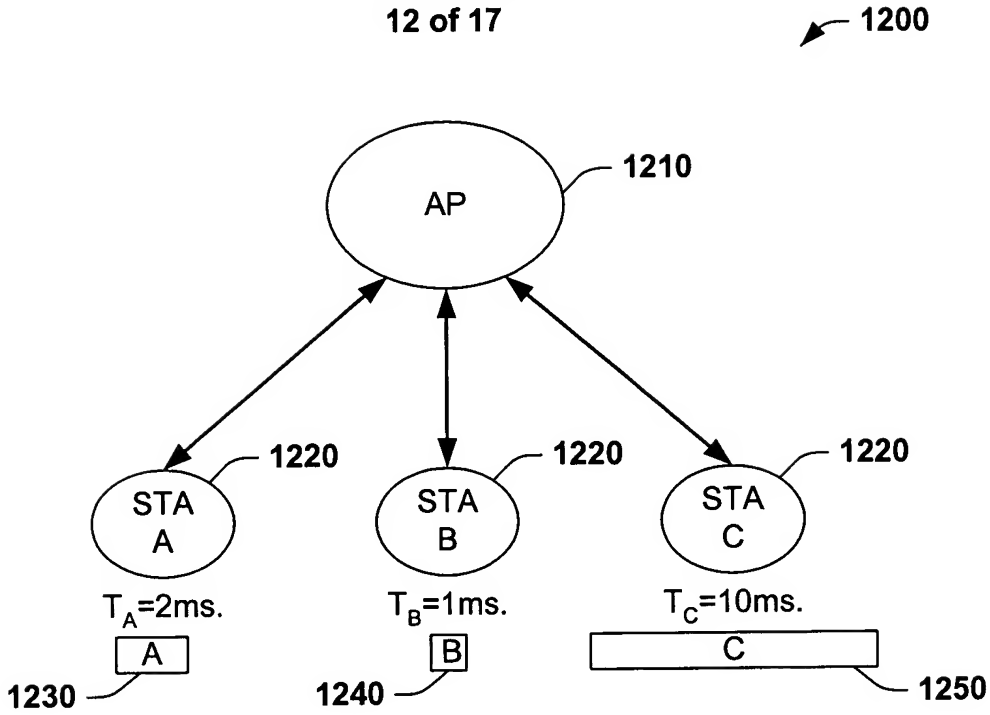

FIG. 12

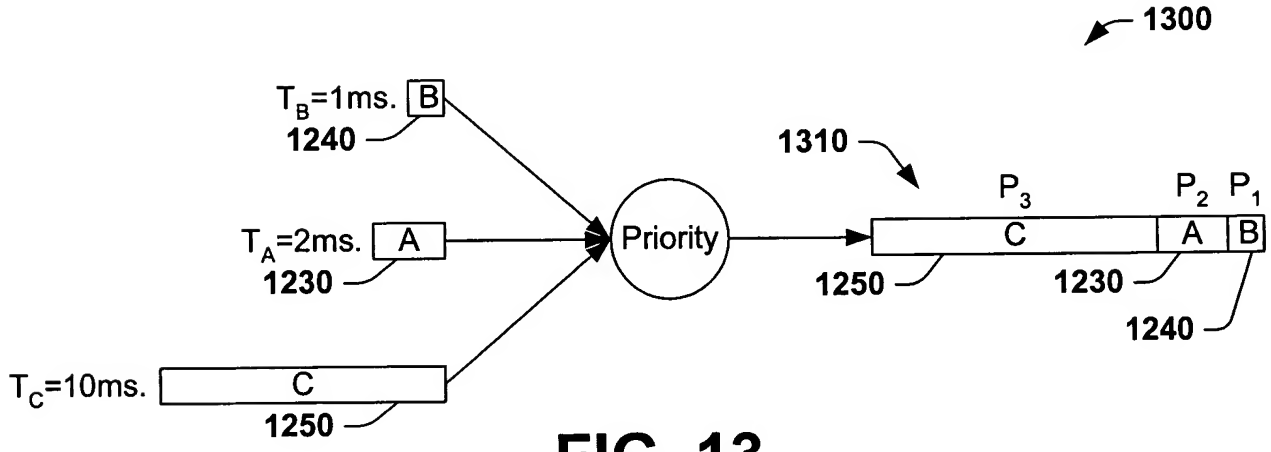

FIG. 13

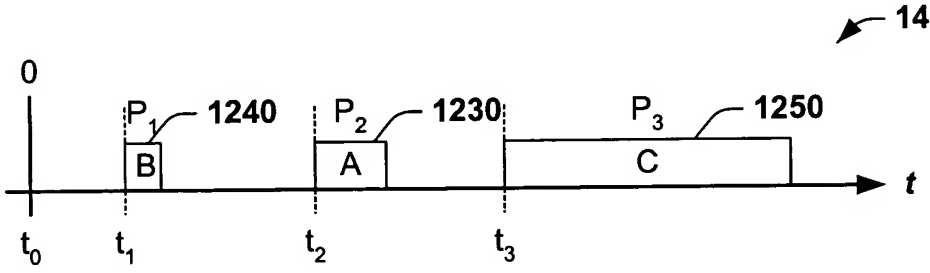

FIG. 14

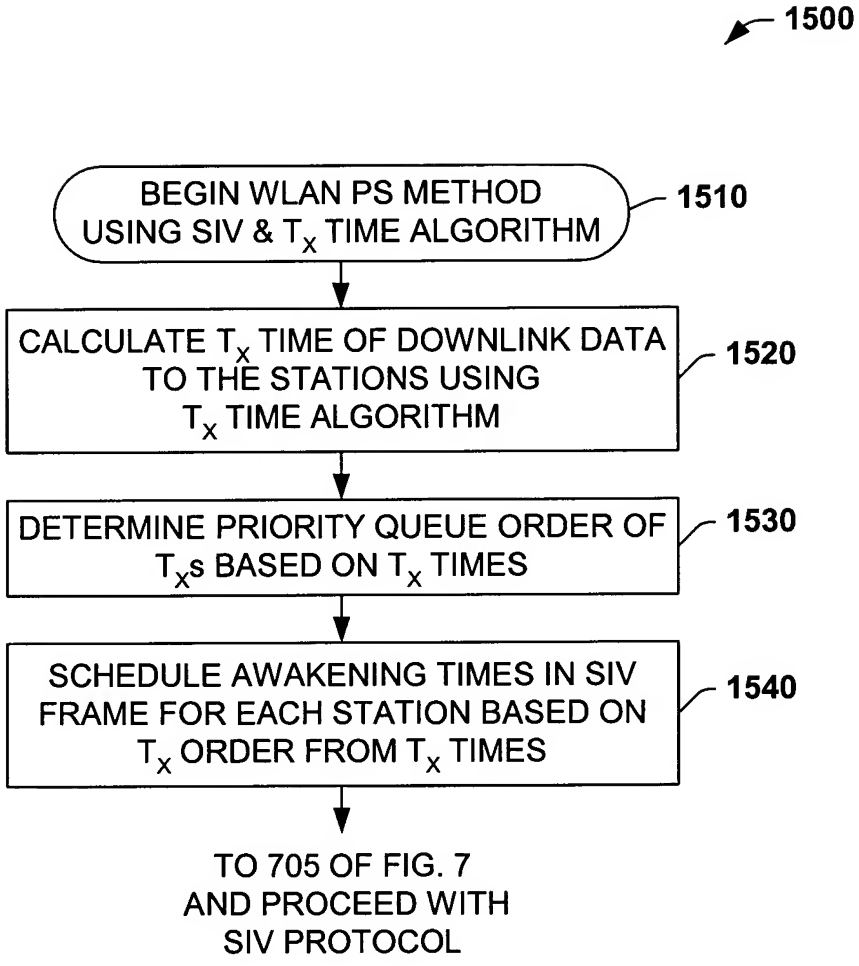
1500
BEGIN WLAN PS METHOD USING SIV & T_X TIME ALGORITHM
1510
CALCULATE T_X TIME OF DOWNLINK DATA TO THE STATIONS USING T_X TIME ALGORITHM
1520
DETERMINE PRIORITY QUEUE ORDER OF T_Xs BASED ON T_X TIMES
1530
SCHEDULE AWAKENING TIMES IN SIV FRAME FOR EACH STATION BASED ON T_X ORDER FROM T_X TIMES
1540
TO 705 OF FIG. 7 AND PROCEED WITH SIV PROTOCOL

FIG. 15

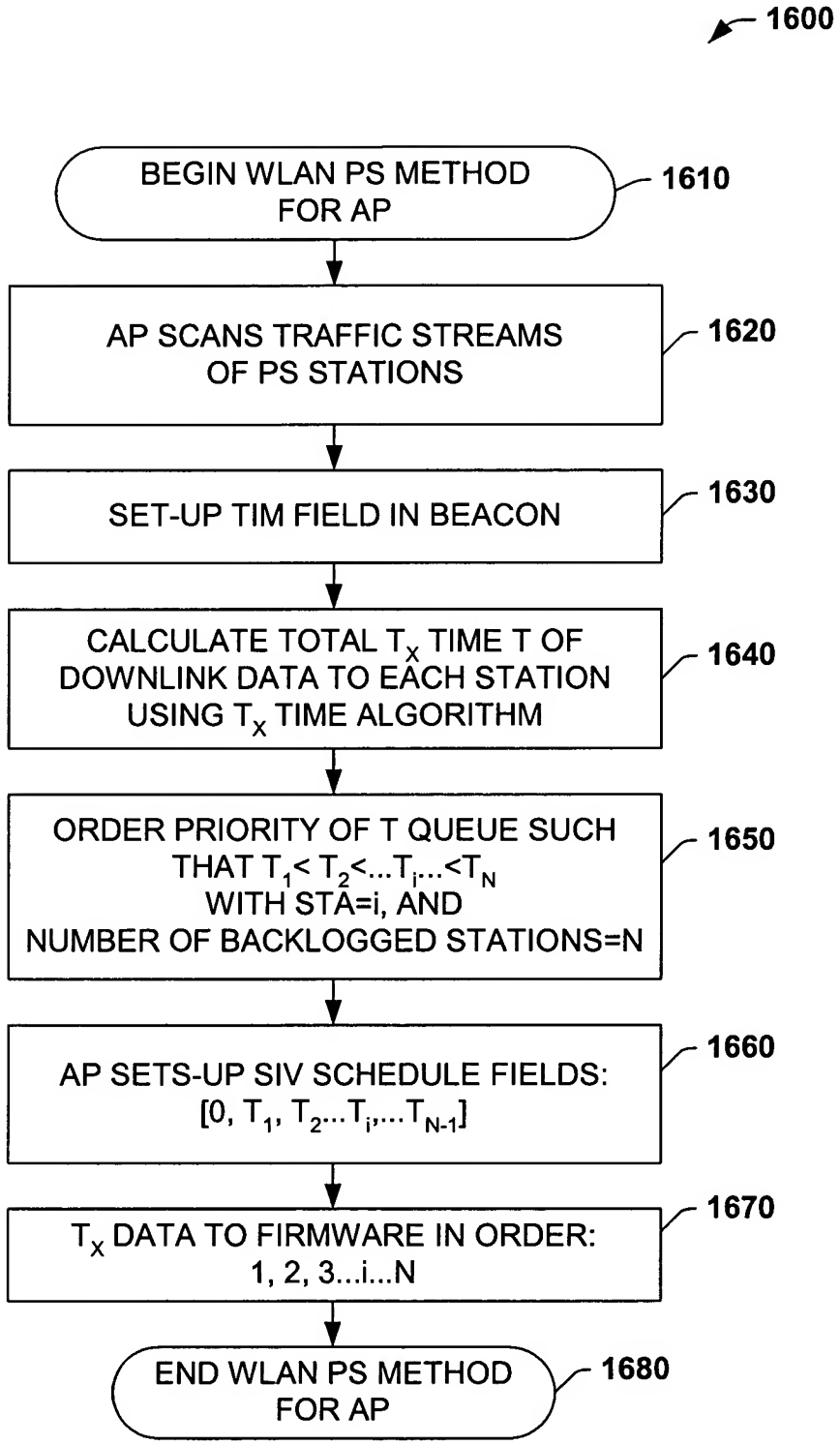
1600
BEGIN WLAN PS METHOD FOR AP
1610
AP SCANS TRAFFIC STREAMS OF PS STATIONS
1620
SET-UP TIM FIELD IN BEACON
1630
CALCULATE TOTAL T_X TIME T OF DOWNLINK DATA TO EACH STATION USING T_X TIME ALGORITHM
1640
ORDER PRIORITY OF T QUEUE SUCH THAT $T_1 < T_2 < ... T_i ... < T_N$ WITH STA=i, AND NUMBER OF BACKLOGGED STATIONS=N
1650
AP SETS-UP SIV SCHEDULE FIELDS: $[0, T_1, T_2 ... T_i, ... T_{N-1}]$
1660
T_X DATA TO FIRMWARE IN ORDER: 1, 2, 3...i...N
1670
END WLAN PS METHOD FOR AP
1680

FIG. 16

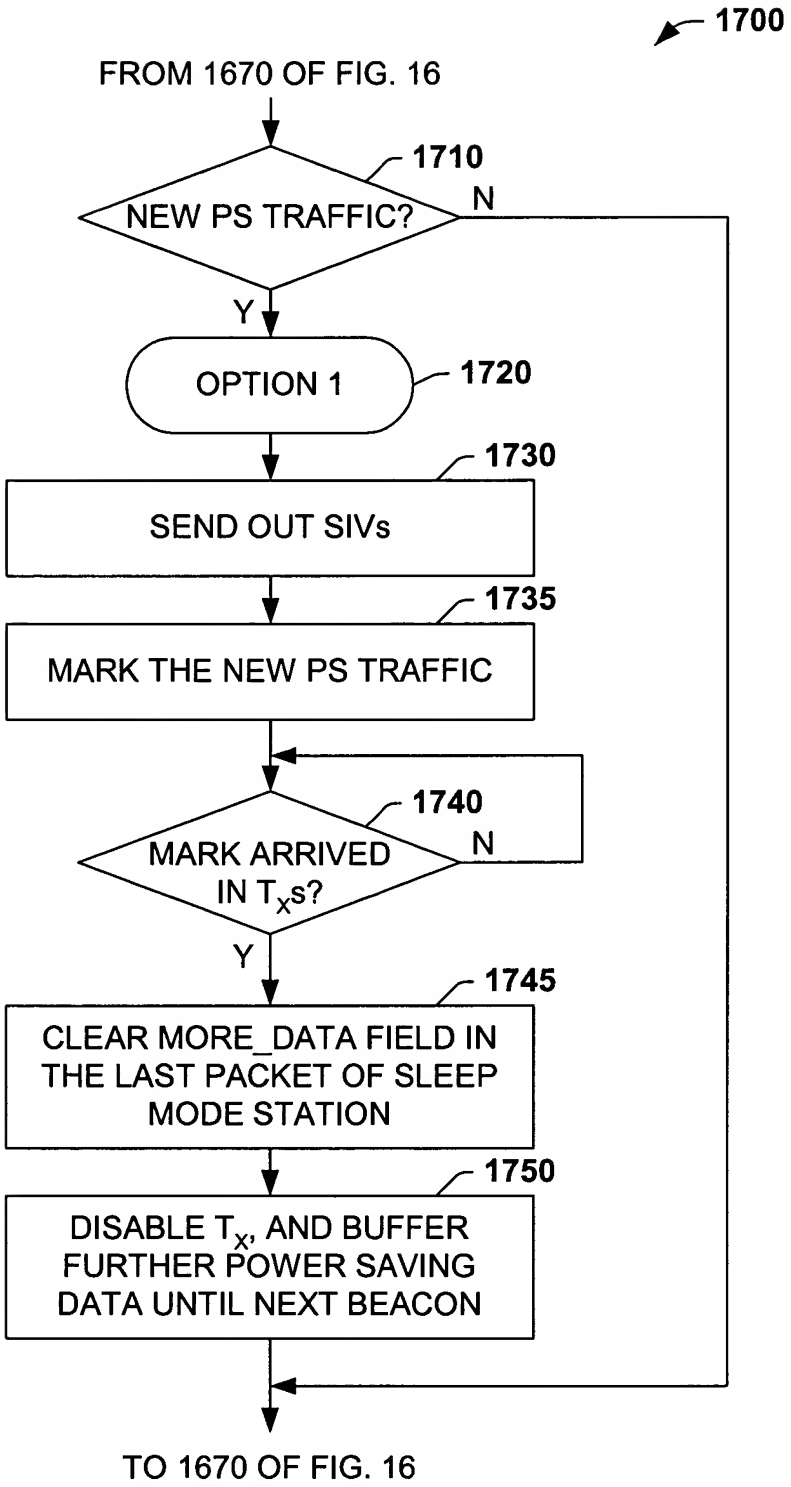
1700
FROM 1670 OF FIG. 16
1710
NEW PS TRAFFIC?
N
Y
OPTION 1
1720
1730
SEND OUT SIVs
1735
MARK THE NEW PS TRAFFIC
1740
MARK ARRIVED IN T_Xs?
N
Y
1745
CLEAR MORE_DATA FIELD IN THE LAST PACKET OF SLEEP MODE STATION
1750
DISABLE T_X, AND BUFFER FURTHER POWER SAVING DATA UNTIL NEXT BEACON
TO 1670 OF FIG. 16

FIG. 17

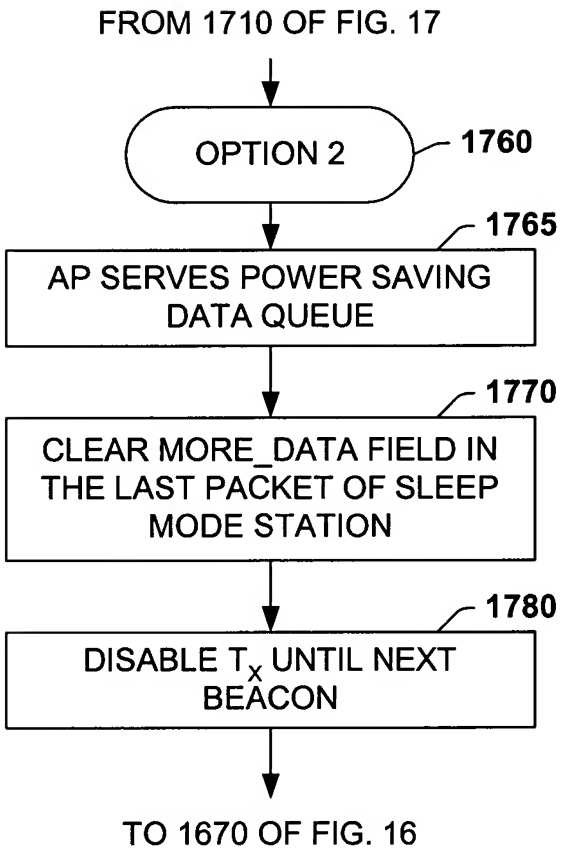
FROM 1710 OF FIG. 17
OPTION 2
1760
1765
AP SERVES POWER SAVING DATA QUEUE
1770
CLEAR MORE_DATA FIELD IN THE LAST PACKET OF SLEEP MODE STATION
1780
DISABLE T_X UNTIL NEXT BEACON
TO 1670 OF FIG. 16

FIG. 18

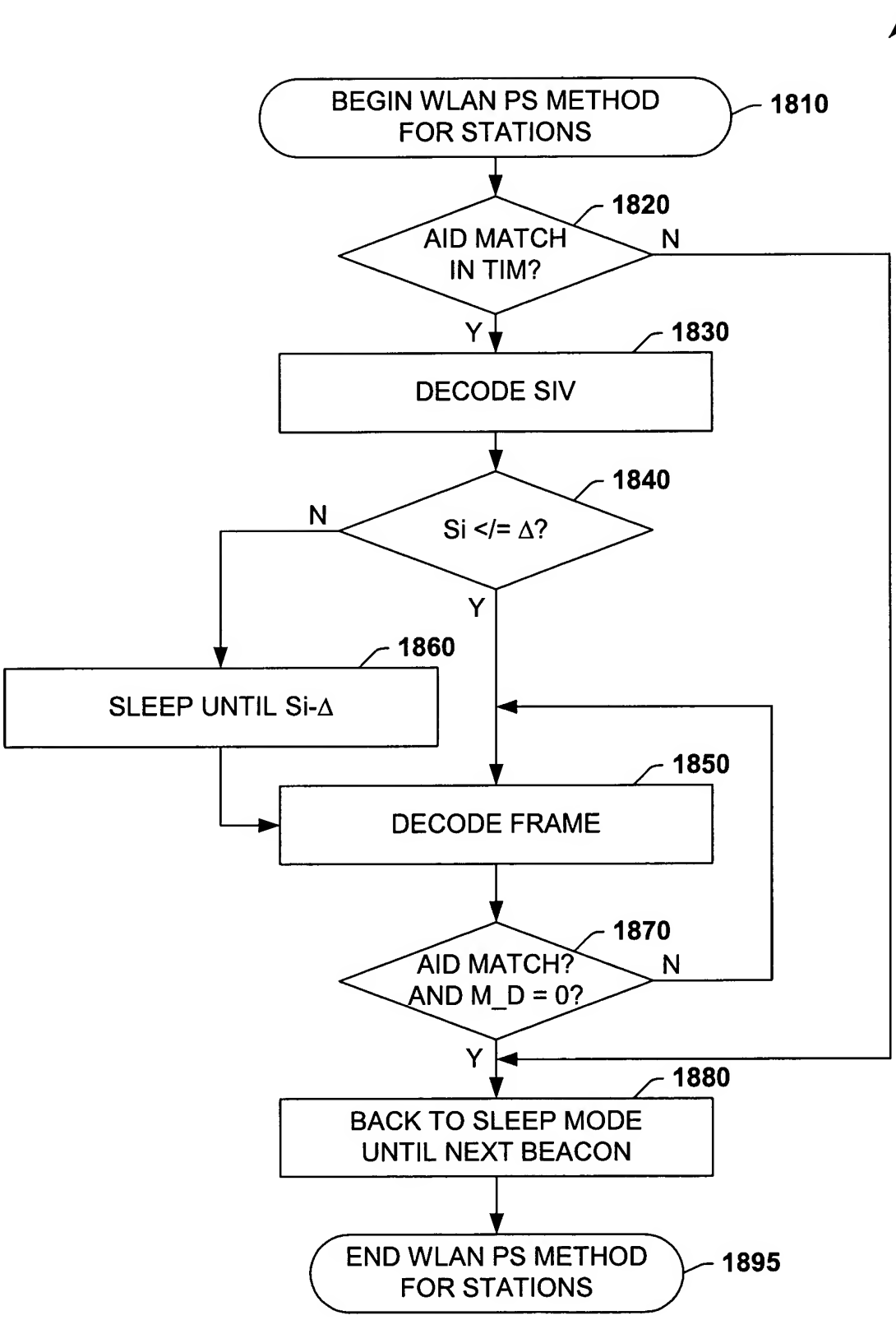
1800
BEGIN WLAN PS METHOD FOR STATIONS
1810
AID MATCH IN TIM?
1820
N
Y
DECODE SIV
1830
Si </= Δ?
1840
N
Y
SLEEP UNTIL Si-Δ
1860
DECODE FRAME
1850
AID MATCH? AND M_D = 0?
1870
N
Y
BACK TO SLEEP MODE UNTIL NEXT BEACON
1880
END WLAN PS METHOD FOR STATIONS
1895

FIG. 19